Verde Valley Amateur Radio Association BPL Committee Report on the Effectiveness of BPL Notching as of October 2, 2004, at the Cottonwood, Arizona Trial Test Sites

To: Sheryl Wilkerson, FCC October 5, 2004

This Notching report is in re: Experimental Station WB9XVP; File No. 0136-EX-2004 at Cottonwood (Yavapai County) Arizona; Broadband Over Power Line System; Request for immediate cessation of Operation and Revocation of Special Temporary Authorization

From the time of the first harmful interference reports from individuals in mid-June and the VVARA filing of initial harmful interference on July 31, 2004, actual adjustments to the system by Electric broadband, LLC did not begin until mid August. Initial notching left quite a bit of interference. (See VVARA filing dated September 11, 2004 to Jim Burtle). Subsequent notching was marginally more effective. However, a problem continues to exist on the following Amateur bands; 17 meters, 15 meters, 10 meters and 20 meters. See appendix A for October 2, 2004 measurements.

These BPL signal readings were measured from an HF mobile station. In a fixed station setting the interference readings from a larger more efficient antenna system will be much higher on the affected bands. Due to the geographically small size of the trial area, no fixed amateur station is currently located near the BPL equipment. Certainly, this will not be the case if BPL is deployed throughout the community.

As evidenced in these most recent measurements, mitigation has not included MARS frequencies, shortwave broadcasts, portions of low VHF and Citizens bands.

Technical Discussion

BPL distributes data by imposing modulation on RF signals that are amplified to appropriate levels and sent over power lines. If unmodulated signals are transmitted over power lines, the amount of radiation in a select portion of the electromagnetic spectrum could be easily reduced by simply excluding RF signals whose fundamental frequency are outside the selected band. It appears that the solution pursued by Electric Broadband is to eliminate the transmission of data within the protected (notched) band. We have no assurance that the operator of this or other similar systems will not employ other frequencies as their needs might dictate which will result in new interference. Absent clear boundaries set down by the Commission, we will constantly be in the form of a ***shell game*** which has already existed here when EB says "We're off" and we find they are "on". The misconception appears to be that by simply not selecting a frequency whose fundamental frequency is in a specific band of frequencies that there is no energy being radiated by the system in the band. There are two principal effects that will create RF energy in a supposed rejected band using notching:

1. Modulation bandwidth of modulated carrier signals and
2. Nonlinearities in amplifier gain blocks causing harmonic content.

Any signal that is modulated with data will, theoretically, be spread over a very wide band including the entire BPL band. The amount of spreading of a signal by data modulation is predominantly influenced by the modulation index that is a design property of the BPL modem. The slopes of the modulation sideband skirts determine how wide a notch must be to reduce the energy in the affected receiver (ham, CB, military user, etc). The level of suppression (or notch) determines the level of in-band spurious signals and must be set to levels where no harmful interference is created. To assure that the harmful interference is not created in a band that is being "notched", measurements are needed to confirm that the modulation sidebands from signals below and above the notched frequency band are being suppressed with an adequate guard band and that the depth of the null is low enough to eliminate harmful interference.

From data published in recent reports by Electric Broadband, LLC, it is clear that notching is being implemented. There does appear to be a noticeable reduction in the radiated power in some bands where notching is attempted. Electric fields in notched bands are on the order of 20 db below the levels above and below the notched bands.

The question remains on whether there is sufficient reduction in the radiated energy in a "notched" band to eliminate interference. What is difficult to determine in the tables produced in the September 16, 2004 report is whether the field intensity levels are measured accurately enough to determine if notching alone can eliminate interference in the notched bands. The local amateurs who used their mobile stations to characterize the levels of radiation are convinced that even with notching certain bands are unusable because of BPL interference. For example, the 17-meter band (~18.1 MHz) is rendered unusable by levels of radiation from the power lines carrying conditioned (notched) BPL signals.

Notching alone can not assure that signals are not emitted on unintended frequencies. Because the BPL system relies upon the regeneration and retransmission of signals at periodic intervals within the network, this means that amplification is needed. A reality of life is that amplifiers are never perfect, one byproduct of amplification is called intermodulation. Intermodulation (intermod) allows energy to be regenerated on frequencies that were not initially transmitted. These signals can be the source in interference. This is a function of the novel properties of each amplifying stage (repeater/retransmitter) and can vary widely. A second issue is that in some cases 'notching' is realized through the use of Digital Signal Processing (DSP). These techniques do not eliminate signals they merely attenuate (reduce) them so DSP notching does not fully equate to elimination of energy.

The proponents of the Cottonwood BPL test have spent hundreds of hours adjusting and readjusting a very small universe of BPL equipment, including bringing in the manufacturers' representatives from abroad practically this amount of attention can not be applied to a large system on a regular basis. The unfortunate recipient of interference must be both technically adroit and articulate if they are to even raise the question to the operators of the system. We have been trying to gain genuine relief since June 17, 2004, and still have received only a modest remedy and little if any exhortation to this end has been forthcoming from the Commission. In a wholesale deployment, the average ham or spectrum user will be totally ill-equipped to articulate the slight being worked upon them.

Summary

Some say that notching by selecting carrier frequencies (sometimes referred to as the DSP solution) will solve the harmful interference problem. The reality is that the problem is solved only when the levels of radiation in the affected bands (ham radio, CB, military, etc) drop below acceptable levels as determined by testing. This may be very difficult to prove in the test cell in Cottonwood, AZ. So far, testing by experts has failed to capture the true levels of field intensities in the notched bands that correlate with an independent assessment. This will probably be incredibly difficult for APS (Arizona Public Service) to maintain if BPL is deployed on a large scale. APS will be inundated with requests to fix problems throughout their network if many tweaks are required to fine tune a system to prevent unacceptable interference levels.

Notching will not be sufficiently effective, by itself, overcome the effects of harmful interference in the HF bands. Even a combination of notching and radiated power limitation will likely be insufficient to overcome the effects of harmful interference.

The additional concern that should be expressed is that there remains no assurance that even if successful 'notching' is implemented today that it will stay in place. By accident or intention the operator of the BPL system perhaps under pressure to increase speed, or service more customers, will have at their disposal the ability to simply re-occupy these portions of the spectrum as they desire. That means that the licensed users of the spectrum must be ever vigilant. In the case of the NTIA they have requested that portions of the spectrum simply be protected ***en banc*** and one might assume that the Commission will so stipulate or otherwise condition the licenses of users who might occupy those segments if the NTIA's request is granted.

Many other users of spectrum in closed systems such as cable TV, are required to annually assert to the Commission their frequency as well as power utilization within those closed conductors, it seems only equitable that a radiating user should be required to account for their activities in a similar fashion. Unless clear rules that are easy to test are in place at the outset and the Commission is prepared to aggressively enforce these rules, the HF spectrum users will experience a major degradation in the use of their licensed bands and the Commission will be the loser in endless hours of wrangling over similar issues for years into the future.

Respectively submitted,

Robert Shipton, K8EQC
Vice President
Verde Valley Amateur Radio Association
BPL Committee Chairman
Cottonwood, Arizona

APPENDIX A

BPL Signal Strength Readings
Recorded October 2, 2004 from 9:50 AM through 1:00PM

Radio and antenna information:

Icom 706 Mark 11 G
Preamp off

Selectivity:	**3.00 khz SSB, CW- (2.4 khz SSB filter)**
	8.00 khz AM
	8.00 khz FMN
	12.00 khz FM

Hustler antenna- 54 inch mast, bumper mounted at right rear corner 2003 Chevrolet pickup. Using Hustler 400 watt resonators for each band with the exception of 160 meter band where 80 meter and 40 meter resonator used for that band.

Coax- is 18 feet RG 58. Rated loss 4.5 DB at 100 feet. Velocity factor- 66%

Signal readings were taken by the following at the 3 BPL sites in Cottonwood, AZ at a distance of approximately 30 feet from the power lines.

Mike Kinney- KU7W
1652 E. Sierra Drive
Cottonwood, AZ. 86326

Norm Vandiver- N7VF
1862 Arena Del Loma
Camp Verde, AZ. 86322

Sawmill Cove Area

Frequency	S Readings/ Comments
1.800- 2.000 mhz-	**No BPL signals detected**
3.500- 4.000 mhz-	**No BPL signals detected**
6.000- 6.900 mhz-	BPL signals detected/ 6.617 mhz- S3 SSB
7.000- 7.300 mhz-	**No BPL signals detected**
7.540 mhz-	BPL signals detected- S5- SSB, S6- AM Started at 7.400 mhz.
10.000- 10.150 mhz	**No BPL signals detected**
10.600 mhz-	BPL signals real faint on SSB
11.000 mhz-	BPL signals real faint on SSB
12.000 mhz-	BPL signals real faint on SSB
13.000- 13.900 mhz-	BPL signals real faint on SSB
14.000- 14.350 mhz-	**No BPL signals detected**
18.068- 18.168 mhz-	**No BPL signals detected**
18.350- 19.000 mhz-	BPL signals detected/ 18.350 mhz- S9 SSB
19.000 mhz-	BPL signals S9 SSB, S9+20 DB- AM
20.000 mhz-	BPL signals S7 SSB, S9- AM
21.000 mhz-	**BPL signals detected S5 SSB, S7 AM**
21.100 mhz-	**S4 SSB, S7 AM**
21.200 mhz-	**S3 SSB, S6 AM**
21.300 mhz-	**S3 SSB, S7 AM**
21.400 mhz-	**S4 SSB, S7 AM**
21.450 mhz-	**S5 SSB, S7 AM**
21.500 mhz-	BPL signals detected S5 SSB
21.614 mhz-	S9+20 DB
22.000 mhz-	S9+10 DB
23.000 mhz-	No BPL signal detected
24.890- 24.990 mhz-	**No BPL signals detected**
26.000- 27.923 mhz-	BPL signals detected S7 SSB on and off intermittent.

28.000- 28.700 mhz-	**BPL signals detected on and off intermittent.**
29.540 mhz-	**S5 SSB intermittent**
29.494 mhz-	**S4 SSB intermittent**
29.700 mhz-	**S4 SSB intermittent**
34.000 mhz-	BPL signals detected faintly
34.190- 35.000 mhz-	S3 SSB, S7 AM
35.543- 36.000 mhz-	S5 SSB, S7 AM
36.016- 37.000 mhz-	S7 SSB, S8 AM
38.600 mhz-	BPL signal drop-off
42.046- 42.700 mhz-	BPL signals faint

American Heritage Academy

1.800- 2.000 mhz-	**No BPL signal detected**
2.538 mhz-	Faint BPL signal detected
3.000 mhz-	S6 SSB, S7 AM
3.424 mhz-	BPL signal drop-off to faint
3.500- 4.000 mhz-	**Little bit BPL signal detected at 3.500 mhz but rest of band clear.**
4.100 5.000 mhz-	BPL signal detected S5 SSB, S6 AM
5.000 mhz-	BPL signal drops off
6.476 mhz-	BPL signal starts up again
6.911 mhz-	BPL signal ends again
7.000- 7.300 mhz-	**No BPL signals detected**
7.400- 7.700 mhz-	BPL signals detected faintly
7.700- 9.000 mhz-	BPL signals detected faintly
9.000- 10.000 mhz-	BPL signals detected faintly
10.000- 10.150 mhz-	No BPL signals detected
10.240- 10.600 mhz-	BPL signals detected faintly
10.600- 11.000 mhz-	S5 SSB, S7 AM
11.000- 12.000 mhz-	S5 SSB, S7 AM
12.000- 13.000 mhz-	S7 SSB, S7 AM
13.000 mhz-	S5 SSB, S7 AM
13.500 mhz-	S5 SSB, S7 AM
13.950 mhz-	BPL signal drops off
14.000 mhz-	**BPL signals detected faint**
14.102 mhz-	**BPL signals drop off**
14.102- 14.350 mhz-	**No BPL signals detected**
16.000 mhz-	BPL signals detected faintly
16.300 mhz-	S5 SSB
16.315 mhz-	S7 SSB
17.000 mhz-	S7 SSB
18.000 mhz-	S7 SSB, S9 AM
18.068 mhz-	**S5 SSB, S6 AM**
18.100 mhz-	**S2 SSB, S6 AM**
18.168 mhz-	**S2 SSB, S6 AM**

18.271 mhz-	S9+20DB SSB, S9+20DB AM
18.900 mhz-	BPL signal drops off
19.000- 20.000 mhz-	BPL signal detected faintly
20.000- 20.900 mhz-	BPL signal detected faintly
21.000- 21.450 mhz-	**No BPL signal detected**
21.600- 22.000 mhz-	BPL signal detected faintly
22.800 mhz-	S7 SSB
23.000 mhz-	S5 SSB
24.000 mhz-	S6 SSB
24.890- 24.990 mhz-	**BPL signal detected faintly**
26.000 mhz-	S-6 SSB, S9 AM
26.902 mhz-	S7 SSB, S9 AM
27.187 mhz-	S8 SSB, S9 AM
27.414 mhz-	S7 SSB, S9 AM
27.800 mhz-	S9 SSB, S9+20 DB AM
28.000 mhz-	**S4 SSB, S6 AM**
28.098 mhz-	**S1 SSB, S5 AM**
28.203 mhz-	**S0 SSB, S4 AM**
28.300 mhz-	**S0 SSB, S4 AM**
28.400 mhz-	**S0 SSB, S4 AM**
28.600 mhz-	**S0 SSB, S4 AM**
28.800 mhz-	**S0 SSB, S4 AM**
29.300 mhz-	**S0 SSB, S1 AM**
29.700 mhz-	**S0 SSB, S4 AM**
34.000 mhz-	BPL signal detected faintly
34.196 mhz-	S7 SSB, S8 AM
35.000 mhz-	S6 SSB, S8 AM
36.000 mhz-	S5 SSB, S6 AM
37.000 mhz-	S5 SSB, S4 AM
37.450 mhz-	S5 SSB, S6 AM
37.940 mhz-	S3 SSB, S6 AM
38.000 mhz-	BPL signal gone
50.000- 54.000 mhz-	**No BPL signals detected**

Birch Street Apartments

1.800- 2.000 mhz-	**No BPL signals detected**
2.500 mhz-	BPL signals detected faintly
3.022 mhz-	S4 SSB
3.184 mhz-	S3 SSB, S7 AM
3.301 mhz-	S4 SSB, S6 AM
3.421 mhz-	BPL signal drops off
3.500- 4.000 mhz-	**No BPL signals detected**
4.100- 4.600 mhz-	BPL signals detected faintly
6.400 mhz-	BPL signals detected faintly
6.500 mhz-	S7 SSB, S9 AM
6.960 mhz-	BPL signal drops off
7.000- 7.100 mhz-	**BPL signal detected faintly**
7.100- 7.300 mhz-	**No BPL signal detected**
7.340 mhz-	BPL signal starts
7.363 mhz-	S6 SSB, S8 AM
8.000 mhz-	BPL signal detected but faint
8.503 mhz-	S0 SSB, S5 AM
8.798 mhz-	S4 SSB, S6 AM
9.022 mhz-	BPL signal drops off to faint
9.950 mhz-	BPL signal drops off to nothing
10.000- 10.150 mhz-	**No BPL signal detected**
10.219 mhz-	BPL signal start faintly
10.501 mhz-	S1 SSB, S6 AM
10.635 mhz-	S9 SSB, S9+30 DB AM
10.681 mhz-	S9+10 DB SSB, S9+30 DB AM
11.000 mhz-	S9 SSB, S9+30DB AM
12.000 mhz-	S9+20 DB SSB, S9+40DB AM
12.500 mhz-	S9+20DB SSB, S9+40DB AM
13.000 mhz-	S9 SSB, S9+20DB AM
13.500 mhz-	S9+30DB SSB, S9+60DB AM
14.000 mhz-	**S7 SSB, S9 AM**
14.100 mhz-	**S6 SSB, S9 AM**
14.260 mhz-	**S6 SSB, S7 AM**
14.303 mhz-	**S4 SSB, S6 AM**
14.350 mhz-	**S4 SSB, S6 AM**

15.000 mhz-	S-1 SSB
15.015 mhz-	BPL signal drops off
16.240 mhz-	BPL signal starts
16.308 mhz-	S6 SSB, S7 AM
17.000 mhz-	S-1 SSB, S3 AM
17.395 mhz-	S0 SSB
17.615 mhz-	S4 SSB, S6 AM
17.967 mhz-	BPL signal drops off
18.068- 18.168 mhz-	**No BPL signals detected**
18.265 mhz-	BPL signals start
18.273 mhz-	S6 SSB, S8 AM
18.868 mhz-	BPL signal drops off
18.977 mhz-	BPL signal starts up again
19.000 mhz-	S1 SSB
20.000 mhz-	S0 SSB, S3 AM
20.900 mhz-	BPL signal drops off
21.000-21.450 mhz-	**No BPL signals detected**
21.595 mhz-	BPL signals detected and start
22.000 mhz-	S6 SSB
22.500 mhz-	S6 SSB
22.775 mhz-	S9+40DB SSB intermittent
23.507 mhz-	S9+40DB SSB intermittent
23.800 mhz-	S9+10DB SSB intermittent
24.000 mhz-	S9+20 DB SSB intermittent
24.500 mhz-	S9 SSB intermittent
24.890- 24.990 mhz-	**BPL signals detected faintly**
26.623 mhz-	BPL signals starts again
26.665 mhz-	S7 SSB, S9 AM
27.000 mhz-	S7 SSB, S9 AM
27.405 mhz-	S7 SSB, S8 AM
27.693 mhz-	S6 SSB, S7 AM
27.927 mhz-	BPL signals drop off
28.000- mhz-	**S3 SSB**
28.010 mhz-	**BPL signal gone**
28.010- 29.700 mhz-	**BPL signals not detected**
34.678 mhz-	BPL signals start Faint
36.000 mhz-	BPL signals detected but faint
38.000 mhz-	BPL signals detected but faint